IEC 63211-2-23

Edition 1.0 2025-03

INTERNATIONAL STANDARD

Durability test methods for electronic displays – Part 2-23: Environmental tests – Outdoor weathering

IEC 63211-2-23:2025-03(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 63211-2-23

Edition 1.0 2025-03

INTERNATIONAL STANDARD

Durability test methods for electronic displays – Part 2-23: Environmental tests – Outdoor weathering

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.120

ISBN 978-2-8327-0254-3

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

DURABILITY TEST METHODS FOR ELECTRONIC DISPLAYS –

Part 2-23: Environmental tests – Outdoor weathering

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 63211-2-23 has been prepared by IEC technical committee 110: Electronic displays. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
110/1643/CDV	110/1687A/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63211 series, published under the general title *Durability test methods for electronic displays*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

This document relates to the common environmental test methods for outdoor weathering of electronic displays, which can overlap with some of the parts of existing IEC TC 110 documents that describe the environmental test methods of individual technologies, such as LCD, OLED, PDP, and others. This document is intended to be used as the reference document in future standards and in revisions of existing ones. The existing standards will be revised in their maintenance time to refer to this document to the largest extent possible.

DURABILITY TEST METHODS FOR ELECTRONIC DISPLAYS –

Part 2-23: Environmental tests – Outdoor weathering

1 Scope

This part of IEC 63211 specifies testing methods and environmental conditions for evaluating durability of displays to be installed outdoor, which covers exposure to solar radiation and rain.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62715-5-3, *Flexible display devices – Part 5-3: Visual assessment of image quality and defects*

IEC 62977-2-1, *Electronic displays – Part 2-1: Measurements of optical characteristics – Fundamental measurements*

IEC 62977-2-2, *Electronic displays – Part 2-2: Measurements of optical characteristics – Ambient performance*

IEC 62977-2-8[1], *Electronic displays – Part 2-8: Measurements of optical characteristics – Reflective displays*

ISO 4892-1:2016, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4892-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

[1] Under preparation. Stage at the time of publication: IEC FDIS 62977-2-8:2025.

3.1
black standard temperature
insulated black panel temperature
characteristic value of the test specimen(s) surface temperature measured by an insulated black panel thermometer, consisting of a black painted stainless steel panel and a resistance temperature sensor embedded in insulating material (white polyvinylidene difluoride (PVDF)) attached

Note 1 to entry: More details are described in ISO 4892-1:2016, 5.2.2.1.

Note 2 to entry: It is designed to approximate the maximum surface temperature of any material with thermal insulating properties and for control in weathering test apparatus.

[SOURCE: ISO 4892-1:2016, 5.2.2.1, modified – notes have been added.]

3.2
black panel temperature
uninsulated black panel temperature
characteristic value of the test specimen(s) surface temperature measured by an uninsulated black panel thermometer, consisting of a black painted stainless steel panel and a resistance temperature sensor attached

Note 1 to entry: More details are described in ISO 4892-1:2016, 5.2.2.2.

Note 2 to entry: It is designed to approximate the maximum surface temperature of any material and for control in weathering test apparatus.

[SOURCE: ISO 4892-1:2016, 5.2.2.2, modified – notes have been added.]

4 Principle

4.1 General

The test specimens to be tested are exposed to laboratory light sources and water sprays under controlled environmental conditions. The methods described include the requirements which have to be met for the measurement of the irradiance and radiant exposure in the plane of the specimen, the temperature of specified white and black sensors, the chamber air temperature and the relative humidity.

4.2 Light source

A xenon arc, fitted with filters, is used to simulate the relative spectral irradiance of daylight in the ultraviolet (UV) and visible regions of the spectrum.

4.3 Environmental conditions

The test specimens are exposed to various levels of irradiance, temperature, relative humidity, and water under controlled environmental conditions.

The exposure conditions are varied by the selection of:

a) the light filter(s);
b) the irradiance level;
c) the temperature during exposure to light;
d) the relative humidity in the chamber during light and dark exposures, when exposure conditions requiring control of humidity are used;
e) the way the test specimens are wetted;
f) the water temperature and wetting cycle;

g) the relative lengths of the light and dark periods.

Wetting is produced by spraying the test specimens with demineralized or deionized water onto the surfaces of the specimens.

5 Apparatus

5.1 Laboratory radiation source

5.1.1 Xenon arc lamp

The radiation source shall comprise one or more quartz-jacketed xenon-arc lamp(s) that emit radiation from below 270 nm in the ultraviolet through the visible spectrum and into the infrared. In order to simulate solar radiation, filters shall be used to remove short-wavelength UV radiation (see Table 1). In addition, filters to remove infrared radiation can be used to prevent unrealistic heating of the test specimen(s), which can cause thermal degradation not experienced during outdoor exposures.

5.1.2 Spectral irradiance of xenon-arc lamp(s) with daylight filters

Filters are used to filter xenon-arc emissions in order to simulate solar radiation. The benchmark of solar radiation in this document is CIE spectral irradiance "CIE-H1" in CIE 241:2020, Recommended Reference Solar Spectra for Industrial Applications, Table 1 [1]. Because laboratory radiation source never exactly reproduces the benchmark, the minimum and maximum levels of the relative spectral irradiance in the UV wavelength range shall conform to Table 1. This table gives the relative irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm.

Table 1 – Relative spectral irradiance of xenon-arc lamp(s) with daylight filters[a]

Spectral passband (λ = wavelength in nm)	Minimum[b] (%)	Maximum[b] (%)	Reference "CIE-H1" (in CIE 241) (%)
$\lambda < 290$	-	0,15	-
$290 \leq \lambda \leq 320$	2,6	7,9	5,9
$320 < \lambda \leq 360$	28,2	39,8	40,4
$360 < \lambda \leq 400$	54,2	67,5	53,8

[a] The minimum and maximum limits in this table are based on more than 100 spectral irradiance measurements with water- and air-cooled xenon-arc lamps with daylight filters from different production lots and of various ages, used in accordance with the recommendations of the manufacturer. As more spectral irradiance data become available, minor changes in the limits are possible. The minimum and maximum limits are at least three sigma from the mean for all the measurements.

[b] The minimum and maximum columns will not necessarily sum to 100 % because they represent the minima and maxima for the measurement data used. For any individual spectral irradiance, the percentages calculated for the passbands in this table will sum to 100 %. For any individual xenon-arc lamp with daylight filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Exposure results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differ by as much as that allowed by the tolerances. Contact the manufacturer of the xenon-arc apparatus for specific spectral irradiance data for the xenon-arc lamp and filters used.

5.1.3 Uniformity of irradiance

The exposure area shall be designed such that the irradiance at any location used for test specimen(s) exposure is at least 70 % of the maximum irradiance measured in this area. If the minimum irradiance at any position in the area used for test specimen(s) exposure is between 70 % and 90 % of the maximum irradiance, the test specimen(s) shall be periodically repositioned to reduce the variability in radiant exposure. The repositioning procedure and schedule shall be agreed upon by all interested parties.

NOTE 1 Procedures for measuring irradiance uniformity by the device manufacturers are given in ISO 4892-1:2016, Annex A.

NOTE 2 Annex A describes some possible specimen placement and repositioning plans and frequencies.

5.2 Test chamber

A laboratory radiation source is used to provide irradiance for the test specimen(s). The test chamber shall be water resistant and means shall also be provided whereby the specified conditions of temperature, air flow and humidity can be maintained within it. The test chamber should be inspected periodically for signs of degradation such as corrosion or colour shift in coated surfaces.

Should any ozone be generated from operation of the lamp(s), the lamp(s) shall be isolated from the test specimens and operating personnel. If the ozone is in an air stream, it shall be vented directly to the outside of the building.

5.3 Radiometer

When a radiometer is used, it shall comply with the requirements outlined in ISO 4892-1:2016, 5.1.7.

5.4 Temperature

The temperature-sensing element shall be shielded from the radiation source and water spray. The chamber air temperature measured at this position is not always the same as the chamber air temperature near the surface of the exposed test specimen(s).

The temperature within the chamber during irradiation shall be controlled in accordance with Table 2. The black standard temperature or black panel temperature shall be controlled (see Table 2). If the test is conducted under other temperature conditions with mutual agreement between interested parties, they shall be reported.

5.5 Humidity

The humidity within the chamber during irradiation and darkness periods shall be controlled in accordance with Table 2. If the test is conducted under other humidity conditions with mutual agreement between interested parties, they shall be reported.

NOTE The relative humidity of the air can have a significant influence on the photodegradation of polymers.

5.6 Spray cycle

The test chamber shall be equipped with a means of directing an intermittent water spray onto the exposed surface of the test specimen(s) under specified conditions. The spray shall be uniformly distributed over the specimen(s). If the test specimen(s) is not flat, the way in which products are sprayed should be determined by agreements between interested parties. The spray system shall be made from corrosion-resistant materials that do not contaminate the water used.

The water sprayed onto the test specimen(s) surfaces shall have a conductivity below 5 µS cm^{-1}, contain less than 1 µg g^{-1} dissolved solids and leave no observable stains or deposits on the test specimen(s). Silica levels shall be kept below 0,2 µg g^{-1}. A combination of deionization and reverse osmosis can be used to produce water of the desired quality. Recirculation of water used for specimen spray is not recommended and shall not be done unless the recirculated water meets the purity requirements listed above.

5.7 Apparatus to assess changes in properties

If an International Standard relating to the determination of the properties chosen for monitoring the changes in properties exists, the apparatus specified by the International Standard concerned shall be used.

6 Test specimens

Test specimens using this test method shall be one of the following configurations and the applied configuration shall be reported:

– display;
– display module;
– display panel.

If the specimen cannot be mounted to apparatus because of oversize, the appropriate size specimen that has the same function and the same system may be used. If a protective cover, for example, is attached when the display is actually installed, it should be included in the test. If active modules or panels are being tested, the electrical connections and circuitry should be protected against moisture exposure. The method used to protect the electrical connections and circuitry should be reported. Specimen should be tested in the non-energized condition. If a specimen is tested in the energized condition, it shall be reported.

7 Exposure conditions

7.1 Radiation

Control the irradiance at the levels indicated in Table 2. Other irradiance levels may be used when agreed on by the interested parties. The irradiance, and the pass band in which it was measured, shall be included in the exposure report.

Table 2 – Exposure conditions and cycles

Exposure cycle using daylight filters with wetting						
Exposure period	**Irradiance[a] [b]**		**Temperature[c]**		**Chamber temperature**	**Relative humidity**
	Broadband (300 nm to 400 nm)	**Narrowband** (340 nm)	**Black standard temperature**	**Black panel temperature**		
	W m^{-2}	W m^{-2} nm^{-1}	°C	°C	°C	%
102 min dry	60 ± 2	0,51 ± 0,02	65 ± 3	63 ± 3	38 ± 3	50 ± 10
18 min water spray	60 ± 2	0,51 ± 0,02	–	–	–	–

If the test is conducted under other conditions with mutual agreement between interested parties, they shall be reported.

NOTE 1 The ± tolerances given for irradiance, temperature and relative humidity are the allowable fluctuations which are defined as the positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions. This does not mean that the set value can vary by plus/minus the amount indicated from the given value.

NOTE 2 Other temperatures (e.g. black standard temperature (75 °C ± 3 °C) or black panel temperature (72 °C ± 3 °C)) can be used when agreed on by the interested parties. The temperature is stated in the exposure report.

NOTE 3 Other conditions for spray such as spray direction, amount of water, duration and the other can be used when agreed on by the interested parties, and those conditions are stated in the exposure report.

[a] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance can be significantly higher than the stated values, e.g. up to 180 W m^{-2} (300 nm to 400 nm) for xenon-arc lamps with daylight filters.

[b] For exposures, either broadband or narrowband for irradiance level shall be controlled.

[c] For materials sensitive to humidity, the use of (65 ± 10) % is recommended.

7.2 Temperature

7.2.1 Black standard and black panel temperature

The black panel temperatures and the black standard temperatures are those most commonly used but have no relationship to each other. Therefore, test results obtained with each other are not always be comparable.

NOTE 1 If a black panel thermometer is used, the temperature indicated will be 3 °C to 12 °C lower than that indicated by a black standard thermometer under typical exposure conditions.

If a black panel thermometer or black standard thermometer is used, then the panel material, the type of temperature sensor and the way in which the sensor is mounted on the panel shall be included in the exposure report.

NOTE 2 If higher temperatures are used as specified in Table 2 for special exposures, the tendency for specimens to undergo thermal degradation will increase and this can affect the results of such exposures.

The black panel temperatures or the black standard temperatures shall be controlled at a specified temperature as indicated in Table 2. Other temperatures (e.g. black standard temperature (75 °C ± 3 °C) or black panel temperature (72 °C ± 3 °C)) may be used when agreed on by the interested parties and shall be stated in the exposure report. When the specimen temperatures are higher than the actual usage temperature, the correlation between weathering test using laboratory light source and outdoor exposure can decrease (refer to ISO 4892-1).

If water spray is used, the temperature requirements apply to the end of the dry period. If the thermometer does not reach a steady state during the dry period after the short water-spray part of the cycle, check whether the specified temperature is reached during a longer dry period, and consider using this longer dry period.

NOTE 3 During the water-spray part of the cycle, the black standard or black panel temperature are close to that of the water used.

NOTE 4 The additional measurement of a white-standard or white-panel temperature with a white-standard/white-panel thermometer in accordance with ISO 4892-1 gives important information on the range of surface temperatures of differently coloured test specimens

7.2.2 Chamber air temperature

The chamber air temperature should be controlled at a specified level (see Table 2). Otherwise, it shall be measured, and it shall be reported.

7.3 Relative humidity of chamber air

The relative humidity should be ~~c~~controlled at a specified level (see Table 2). Otherwise, it shall be measured and it shall be reported.

7.4 Spray cycle

The spray cycle used shall be as agreed between the interested parties but should preferably be that indicated in Table 2.

Other condition for spray such as spray direction, amount of water, duration and the other parameters may be used when agreed on by the interested parties and shall be stated in the exposure report.

7.5 Cycles with dark periods

The conditions in Table 2 are valid for continuous presence of radiant energy from the source. More complex cycles may be used. These can include dark periods that can involve high humidity and the formation of condensate on the surfaces of the specimens.

Such programmes shall be given, with full details of the conditions, in the exposure report.

8 Procedure

8.1 General

It is recommended that at least three test specimens are exposed in each run to allow statistical evaluation of the results.

8.2 Initial measurements

Specimen should be evaluated before, intermittent, and after exposure test for visual inspection, optical performance and image quality. Visual inspection shall be performed in accordance with IEC 62715-5-3. Optical performance measurement shall refer to IEC 62977-2-1 for darkroom measurement and IEC 62977-2-2 for ambient measurement. For reflective displays IEC 62977-2-8 shall be referred. Other properties may be used if agreed upon by all interested parties.

8.3 Mounting the test specimens

The test specimen(s) to be tested shall be placed on a specimen holder or a specified substrate as stated in the relevant specification and so spaced from other specimens in order to avoid shielding from the source of radiation. Temperature sensors should be attached to the test specimen(s) if required.

8.4 Exposure

Before placing the specimens into the test chamber, be sure that the apparatus is operating under the desired conditions (see Clause 7). Programme the apparatus with the selected conditions to operate continuously for the required number of cycles at the selected exposure conditions. Maintain these conditions throughout the exposure, keeping to a minimum any interruptions to service the apparatus and to inspect the specimens.

8.5 Measurement of radiant exposure

If used, mount and calibrate the radiometer so that it measures the irradiance at the exposed surface of the test specimen.

When radiant exposures are used, express the exposure interval in terms of incident radiant energy per unit area of the exposure plane, in joules per square metre (J m^{-2}), in the wavelength band from 300 nm to 400 nm, or in joules per square metre per nanometre (J m^{-2} nm^{-1}) at the wavelength selected (e.g. 340 nm). The incident irradiance, I, on the exposure plane over the exposure interval, t, is measured. Then the radiant exposures as the incident radiant energy per unit area are calculated by multiplying I by t for the specific wavelength band.

8.6 Final measurements

The test specimen(s) shall be evaluated against the final measurements, which are conducted in the same manner as the initial measurements.

9 Information to be given in the test report

The report of the test result shall include the following:

– description of the test specimen;
– methods and results of initial, intermittent, and final measurements;
– test conditions and measurement values (temperature, humidity, irradiance, etc.);
– temperature sensor type used;
– test period or radiant exposure;
– any deviation from the specified test procedure.

The followings shall be recorded in the experimental note:

– test apparatus (manufacturer, model number, etc.).